Breeding behaviour of the Barred Frog *Mixophyes coggeri*

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Citation: Hoskin, C.J. 2010 03 15. Breeding behaviour of the Barred Frog *Mixophyes coggeri*. *Memoirs of the Queensland Museum — Nature* 55(1): 1-7. Brisbane. ISSN 0079-8835. Accepted: 26 March 2007.

ABSTRACT

A recent analysis of specimens assigned to the Northern Barred Frog *Mixophyes schevilli* Loveridge, 1933 of the Wet Tropics region of north-east Queensland revealed three genetically and morphologically distinct species (Mahony et al. 2006). *Mixophyes schevilli* was retained as a species distributed in the northern and central Wet Tropics, *M. coggeri* Mahony, Donnellan, Richards & McDonald, 2006 was described as a species distributed throughout the Wet Tropics, and *M. carbinensis* Mahony, Donnellan, Richards & McDonald, 2006 was described as a species restricted to the Carbine and Windsor Tablelands (Mahony et al. 2006). All three species are large, terrestrial, rainforest-restricted stream breeders. Importantly, the calls and breeding biology of the three species have not been described, and differences in habitat preferences and other ecological aspects have not been resolved. Here I present the advertisement (mating) call of *M. coggeri* and an observation of the breeding behaviour of this species. The call is a deep, reverberating 'worg' and the primary call parameters are presented. The breeding behaviour is described in detail and is characterised by the female flicking fertilised eggs up onto rocks and the bank overhanging a side-pool in the stream. The calls and breeding biology of the other two Wet Tropics *Mixophyes* species remain unresolved.
❐ *advertisement call, oviposition, Myobatrachidae, Australia, north-east Queensland, Wet Tropics.*

Until recently *Mixophyes schevilli* was the sole described *Mixophyes* species from the rainforest of the Wet Tropics region, between Townsville and Cooktown in north-east Queensland. A recent analyses, however, split *M. schevilli* into three genetically and morphologically distinct species in the Wet Tropics: two widely distributed species, *M. schevilli* and *M. coggeri*, and a species restricted to the Carbine and Windsor Tablelands, *M. carbinensis* (Mahony et al. 2006). Little information has been published on the breeding biology of *Mixophyes schevilli*, the call is generally described as a deep 'wark' (e.g. Barker et al. 1995; McDonald 2000) and oviposition has been reported as eggs 'laid on soil under banks above water' (McDonald 2000). The recent revision of *M. schevilli* makes it unclear which of the three species this information referes to, and descriptions of the breeding behaviour of each species are required. The breeding behaviour of the Wet Tropics species is of particular interest given the diversity in call structure and egg laying behaviour among the four *Mixophyes* species in south-east Australia (discussed below). Here I describe the call and a breeding observation of *M. coggeri* from the Kuranda region in the central Wet Tropics. *Mixophyes coggeri* occurs in lowland and upland rainforest through much of the Wet Tropics region, from Paluma (near Townsville) to Big Tableland (near Cooktown)

(Mahony et al. 2006). Across much of this distribution the species co-occurs with *M. schevilli*, while on the Carbine and Windsor Tableland it is sympatric with *M. carbinensis* (Mahony et al., 2006).

The calls, breeding observation and habitat notes presented herein come from the Kuranda region (16°45'-16°51'S, 145°33'-145°40'E, altitude 300-450m), west of Cairns. In this region I have observed *M. coggeri* across the full spectrum of rainforest types, from well-developed wet rainforest to thin riparian rainforest strips in otherwise open, sclerophyll-dominated forest. *Mixophyes coggeri* calls from the vicinity of pools on slow-moving streams that range in substrate from sandy and boggy through to rocky. Males and females are regularly observed foraging at night, generally along stream banks and at times some distance from streams. I have not observed *Mixophyes schevilli* at these sites, although it is known to occur in the Kuranda region (Mahony et al., 2006). All individuals herein were identified as *M. coggeri* based on the diagnostic morphological and pattern characters presented in Mahony et al. (2006): dorsal pattern consisting of a series of irregular blotches (e.g. Fig. 1), large size (male SVL > 80 mm) (Table 1), broad head shape (HW/SVL 0.45-0.47) (Table 1), and aspects of the patterning of the posterior surface of the thigh.

CALL CHARACTERISTICS

The calls of three male *M. coggeri* were recorded on Streets Ck (16°49'34"S 145°39'22"E) between 21:00 and 23:30 hrs on 1 March 2007. These were the only *M. coggeri* calling along a 350 m stream transect that night and no females were observed. Males 1 and 2 were calling on opposite sides of the stream where a deep stream pool flowed into riffles, and male 3 was calling 150 m upstream near a stream pool between cascades (Fig. 2A). The weather was overcast, warm, humid and still. All three males were calling from elevated earthy stream banks approximately 3 m from the water and were partly covered by leaf-litter but with the front half of the body exposed. Calls were recorded with a Marantz DAT recorder and a Sennheiser directional microphone, and air temperature was taken (Table 1). Following recording, each frog was placed in a clear plastic bag and identified and measured (Table 1), after which it was released at the exact point of capture and photographed. Male 3 was identified as that involved in the breeding observation the previous night (described below), based on a comparison of the dorsal pattern in photographs and the fact that male 3 was calling within 5 m of where the breeding pair had been found the previous night. The software Soundruler 0.9.6.0 was used to measure the following call parameters: call interval (time from the end of one call to the beginning of the next), call duration

TABLE 1. Call characteristics of *Mixophyes coggeri*. Table presents the average and range (in brackets) of each call parameter for three males, along with their snout to vent length (SVL), tibia length (TL), head width (HW), HW to SVL ratio (HW/SVL), and the air temperature (T°C). The last row is the average of all traits across the three males.

Individual	SVL (mm)	TL (mm)	HW (mm)	HW/ SVL	Call int. (sec.)	Call duration (sec.)	Pulses per call	Pulses per sec.	Dominant Freq. (Hz)	T°C
Male 1	87.2	52.6	39.6	0.45	31 (8-67)	0.218 (0.216-0.219)	13 (13-13)	59.7 (59.4-60.1)	536 (520-550)	23.5
Male 2	82.4	54.4	38.6	0.47	65 (29-78)	0.220 (0.200-0.237)	13 (12-14)	60.0 (59.2-60.4)	576 (560-580)	23.5
Male 3	85.8	51.9	40.1	0.47	31 (16-48)	0.259 (0.257-0.260)	15 (15-15)	58.0 (57.6-58.5)	574 (560-580)	23.0
Average	85.1	53.0	39.4	0.46	42	0.232	14	59.2	562	23.3

FIG. 1. *Mixophyes coggeri*, pair in amplexus.

(time from the beginning of the first pulse to the end of the last pulse), pulses per call, pulse rate (number of pulses divided by call duration), and dominant frequency (frequency at which the call is of greatest intensity). Five successive calls were analysed for each male to give the average and range for each call parameter for each male (Table 1).

The typical advertisement call of *M. coggeri* in the Kuranda region is a deep,

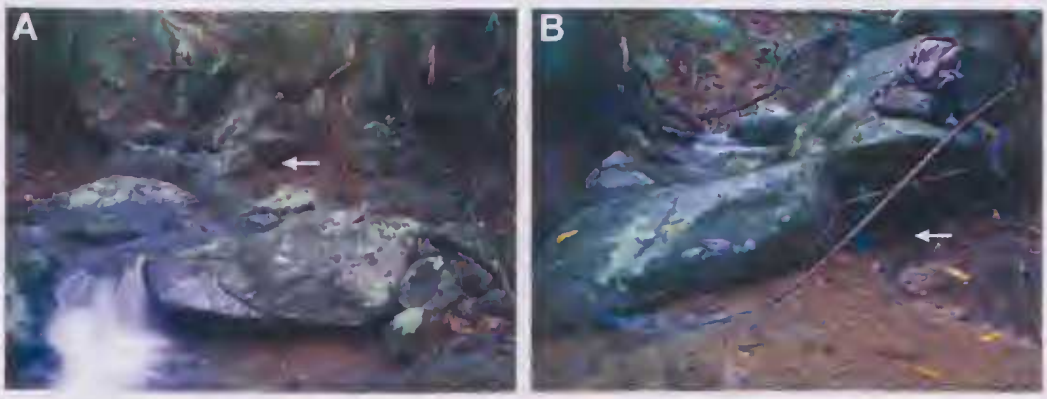

FIG. 2. Stream habitat on Streets Ck, with the oviposition site being the rock overhang marked by an arrow in photo A and in the close-up photo (B).

FIG. 3. *Mixophyes coggeri* eggs adhered to the under surface of the rock overhang 12 hours after laying.

reverberating 'worg' repeated infrequently. Call parameters of the three males recorded at Streets Ck are presented in Table 1. Of the approximately 50 calls recorded all were a single 'worg', except one which was a double 'worg worg'. More recordings are required to assess call variation in *M. coggeri* across the extent of its range.

I have heard a distinctly different, higher pitched and less reverberating 'wark' or 'wark wark' call at other sites in the northern and central Wet Tropics, similar to that presented for '*M. schevilli*' by Stewart (1998a). This is likely to be the mating call of *M. schevilli* but will remain unresolved until the call of this species is characterised and matched with genetic or morphology/pattern data. I have also recorded a similar 'wark' call from *Mixophyes* on the Windsor Tableland (where *M. schevilli* has not been recorded (Mahony et al. 2006)) from males that match the morphology of *M. carbinensis* but not *M. coggeri*. This suggests the call of *M. carbinensis* is similar to that of *M. schevilli* and differs from the deep, reverberating call of *M. coggeri*. However, once again this requires recordings matched with genetic or morphology/pattern data.

BREEDING OBSERVATION

An observation of *M. coggeri* breeding was made on Streets Ck on the night of 28 Febuary/1 March 2007. Weather conditions were overcast, warm (25°C), humid and still on the night. Heavy rain had fallen over the previous fortnight but little had fallen over the previous few days and the stream level had dropped back to a 'normal' level. A pair of *M. coggeri* were found in amplexus (Fig. 1) at 22:30 hrs, halfway up a steep earthy bank and about 1m from the edge of a shallow side-pool connected to the stream (top right of Fig. 2A). Amplexus at this stage was axillary,

with the male clasping the female just behind the pectoral region. The pair remained amplexed for the remainder of the observations but movements described below were those of the female as she was carrying the male. Movement was characterised by short bursts of activity by the female separated by long periods where the pair remained perfectly still. At 23:45 hrs the female moved to the edge of the side pool (mid right of Fig. 2A) and the pair sat there until 00:30 hrs when the female worked her way through the middle of a rock pile in the creek, ending up in a shallow pool beneath a rock overhang (marked on Figs 2A & B). At 00:45 hrs the pair emerged from the overhang and sat on the edge of the main stream pool (mid right of Fig. 2B) until 01:30 hrs when the female moved around the side-pool back to the point where they first approached the stream (mid right of Fig. 2A). The pair nestled into muddy leaf-litter on the edge of the side-pool for 10 minutes before the female jumped into the side-pool, swam across it and then carried the male back through the rock pile to the small pool below the overhang (01:45 hrs). At this point no eggs had been laid in the overhang or in the side-pool. The position of the male had changed such that at this stage amplexus appeared inguinal (axillary earlier). The pair moved around in the small shallow pool below the overhang (marked in Figs 2A & B) and then at about 02:00 hrs started flicking eggs and water up onto the ceiling and walls of the rocky overhang. Sitting or floating in shallow water the female would pause, lean forward and flick a spray of eggs and water upwards with her back legs (presumably immediately after the eggs had emerged from her cloaca and been fertilised by the male). Then the amplexed pair would move around in the pool, pause, and flick again. The egg flicking behaviour was similar to that photographed in *M. fasciolatus* Günther, 1864 (Anstis 2002, p. 218). This behaviour was still continuing at 02:30 hrs when observations were ceased, and at this point eggs and dripping water were evident on the roof of the overhang and to a lesser degree on the adjacent sloping rock walls and earth banks.

FIG. 4. *Mixophyes coggeri* egg 8 days after laying. The tadpole is clearly discernable on the left hand side of the egg, with its head facing forwards and the tail curving away to the right. The tadpole hatched out during rainfall shortly after the photograph was taken.

Observations the next day (1 March 2007) revealed the pool beneath the overhang to be about 80 cm long, 40 cm wide and from 5-15 cm in depth. The rock above the pool made a roof about 20-30 cm above the water surface and the pool was almost completely surrounded by sloping rock and earth, with just two small 1 cm deep channels linking it to the stream (Fig. 2B). The rock pile was positioned between a slowly flowing pool (3 m wide, 50 cm deep) in the main stream channel and a linked side-pool (2 m wide, 20 cm deep) (Fig. 2A). Most eggs (approximately 300) were stuck to the rock roof of the overhang (Fig. 3) and were clumped (but generally in a single layer) directly above the water in a 60 cm by 30 cm strip, about 20 cm above the water surface. Others (approximately 150 eggs) were scattered on the sloping earth bank and sloping rocks around the pool, generally within 10 cm (but up

to 30 cm) from the water, and a small number of eggs (about 40) were visible in the water. This gives a clutch size estimate of about 500 eggs. The eggs were pigmented (creamy brown) and with visible animal and vegetal poles (Fig. 3). The eggs stuck to the overhang hung with their darker, animal pole upwards. The egg diameter averaged about 3.8 mm (about 4.2 mm including the firm, clear egg capsule).

When I returned seven days later (8 March 2007) no live eggs were observed on the roof of the overhang but a small number of dry, shrivelled eggs (approximately 50) remained. I assume the remainder had hatched out and dropped into the pool. Approximately 50 eggs were still present on an earthy bank above the waters edge and these were now large and a well-developed larva was clearly visible in each (Fig. 4). The larva in the eggs resembled the few hatchlings that were visible in the pool below the overhang. It had rained very little since egg laying and the water level in the pool had dropped and it was now isolated from the stream. Heavy rain began falling as the observations were being completed and an egg on an earth bank about 5cm from the water was observed to rupture as it was wet by water dripping off rocks into the overhang. The hatchling wriggled vigorously until it entered the shallow pool. The hatchling was patterned with dark and golden markings and a dark bar across the base of the tail. Observations ceased due to heavy rain and it was assumed that other eggs would have hatched as water ran off rocks into the overhang, and that the pool below the overhang would have re-connected with the rising stream. Overall, the egg laying behaviour and development of the eggs is similar to that described for *M. fasciolatus* and *M. iteratus* Straughan, 1968 (Anstis 2002; Harry Hines, pers. comm.).

DISCUSSION

The mating call and breeding biology of the Wet Tropics *Mixophyes* species is of particular interest given the differences observed between the four south-east Australian species, which can be broken into two groups based on call structure and breeding behaviour/habitat: 1. *M. fasciolatus* and *M. iteratus* give a 'wark' or 'woh' style call and their breeding behaviour is characterised by the female (in amplexus) flicking fertilised eggs up onto rocks or banks overhanging stream pools, whereas, 2. *M. fleayi* Corben & Ingram, 1987 and *M. balbus* Straughan, 1968 give a stuttered 'ok-ok-ok-ok-ok' style call and lay their eggs in a circular depression (constructed by the female during amplexus) in gravel or leaf-litter in shallow stream riffles (Barker et al. 1995; Stewart 1998b; Lewis 2000; Meyer et al., 2001; Anstis, 2002). The call and breeding biology of *M. coggeri* conforms to group 1 (*M. fasciolatus* and *M. iteratus*). In particular, *M. coggeri* shows similarities to *M. iteratus* in being of very large body size and having a deep, reverberating call. Further research is required to assess call variation across the range of *M. coggeri* and to resolve the mating call and breeding biology of *M. schevilli* and *M. carbinensis*. This will determine whether the Wet Tropics *Mixophyes* display the variation in call structure and breeding behaviour seen in the south-east Australian species. Characterising differences in the advertisement call and habitat requirements between the three Wet Tropics species will also allow an assessment of the mechanisms of reproductive isolation between the sympatric species pairs.

ACKNOWLEDGEMENTS

I thank Greg Dawe and Eleanor Hoskin for assistance, and the reviewers for constructive comments. The research was conducted during a Tropical Landscapes Joint Venture Project between James Cook University (Miriam Goosem) and the Queensland Department of Main Roads, assessing the impact of highways on frogs.

LITERATURE CITED

Anstis, M. 2002. *Tadpoles of south-eastern Australia: a guide with keys.* (New Holland: Sydney).

Barker, J., Grigg, G. & Tyler, M. 1995. *A field guide to Australian frogs.* (Surrey Beatty & Sons: Sydney).

Cogger, H.G. 2000. *Reptiles and amphibians of Australia* (6th ed.). (Reed New Holland: Sydney).

Hero, J.-M. & Fickling, S. 1997. *A guide to stream-dwelling frogs of the Wet Tropics rainforests.* (James Cook University: Queensland).

Lewis, B. 2000. A breeding observation of the Stuttering Frog (*Mixophyes balbus*) in northern New South Wales. *Herpetofauna* **30**: 30-33.

Mahony, M., Donnellan, S.C., Richards, S.J. & McDonald, K. 2006. Species boundaries among barred river frogs, *Mixophyes* (Anura: Myobatrachidae) in north-eastern Australia, with descriptions of two new species. *Zootaxa* **1228**: 35-60.

McDonald, K.R. 2000. Frogs. *In*: *Wildlife of Tropical North Queensland*. eds. M. Ryan & C. Burwell. (Queensland Museum: Brisbane).

Meyer, E., Hines, H. & Hero, J.-M. 2001. *Wet forest frogs of south-east Queensland.* (Griffith University: Queensland).

Stewart, D. 1998a. Audio CD: Australian frog calls: tropical north-east. (*Nature Sound*: Mullumbimby, NSW).

1998b. Audio CD: Australian frog calls: subtropical east. (*Nature Sound*: Mullumbimby, NSW).